joint fibrous roots were sent out and from many of the joints there grew leafy stems, a meter or more in height. A careful investigation showed that these long trailing stems were at first underground stems, and that after growing under the surface for some distance, the sand had been removed by the shifting currents of water, thus exposing the stems to the air. These exposed stems, thereafter grew as stolons running over the surface as described above. I am told that occasionally these running stems almost entirely cover portions of the islands, and the broad sand-bars along the margins of the river.—CHARLES E. BESSEY.

Barnes and Heald's Keys to Mosses.—Botanists will welcome the new, revised and extended "Analytic Keys to the Genera and Species of North American Mosses" which appeared in January of the present year, as one of the Bulletins of the University of Wisconsin. The thick pamphlet includes about 220 octavo pages, eight of which are devoted to a brief introduction, thirteen to the key to the genera, eighty-one to the key to the species, and one hundred and eighteen to descriptions of the species and varieties which have been published since the issue of Lesquereux and James's Manual in 1884. Under the latter there are enumerated, six hundred and three forms, many of whose descriptions are here available for the first time to most American botanists. The work can not help but stimulate the collection and study of mosses, in the botanical departments of our colleges and universities, and it should do somewhat to excite the interest of pupils in the high schools, academies and other secondary schools in which pupils pursue elementary botany. There is no good reason why students who are admitted to the Freshman classes of our colleges and universities should be wholly ignorant of the structure and relationship of the mosses, and this book (which may be obtained for one dollar) will be helpful to all teachers and pupils who wish to make an offort to know something of these interesting plants.—CHARLES E. BESSEY.

VEGETABLE PHYSIOLOGY.

What is Leuconostoc mesenteroides?—This organism was first described by Cienkowsky in 1878, under the name of *Ascococcus mesenteroides*. He obtained his material from beet sugar vats, and described the organism as consisting either of rods or coccus forms. The gelatinous clumpy masses had been familiar to sugar makers for a

long time, and often multiplied enormously in the beet juice, forming cart-loads of the so-called "frog spawn." In 1878 van Tieghem also studied the organism (*Ann. d. Sci. Nat. Bot.* Sé. 6. t. 7. p. 180), considered it to be closely related to Nostoc, and renamed it *Leuconostoc mesenteroides.* His observations contradicted those of Cienkowski in several important particulars. He found no rod-shaped bodies, but only a coccus, which, in exhausted material converted some of its members into spores, particular cells of the chain enlarging perceptibly, becoming more refractive, and taking on a thicker wall. His first material was discovered in the laboratory by accident in macerations of dates and carrots. Subsequently the organism thus found was compared with that from the beet sugar vats and found to be identical. In 1892, Liesenberg and Zopf published two papers which threw a flood of light on the subject (Zopf: Beiträge I and II). They first obtained the organism from the Spree River water, below certain breweries, starch factories, etc. This form was subsequently compared with material from a beet sugar factory in Germany, and found to be identical. Their experiments covered a period of two years, and were carried along in two parallel series (1) with the European organism and (2) with material obtained from cane sugar vats in Java. The Javan and European form proved to be morphologically identical, and there were only a few very slight physiological differences. The organism as it comes from the vats is always contaminated with other bacteria, which stick to the gelatinous sheath. Pure cultures were therefore obtained with some difficulty, and only after it was discovered that the contaminating bacteria could be destroyed by heat without injury to the Leuconostoc. Poured plates made after exposing the finely rubbed mass in fluid to 75° C. for 15 minutes invariably yielded an abundance of pure colonies. The organism is plainly dimorphic. In solid or fluid nutrient media containing grape or cane sugar it multiplied in the ordinary gelatinous or cartilaginous, lumpy, frog spawn form. In similar media destitute of grape or cane sugar it grew in an entirely different form, i. e., as an ordinary, thin-walled Streptococcus. The two forms were so remarkably different both macroscopically and microscopically that the Streptococcus form was at first supposed to be some intruding organism; but repeated transfers of the two forms back and forth always gave the same results, i. e., the frog spawn form on nutrient media containing sugar, and the nude form on the same media when free from cane or grape sugar. The change from the nude to the covered form was followed in hanging drop cultures, and occurred in 12 to 24 hours. In nature the organism probably most often occurs in a form quite unlike that found

in the sugar vats. Transitions to the nude form were also observed in old sugar cultures, which had become acid from the growth of the organism. Moreover, the tough, shiny, elastic cartilaginous form developed on sugar media during the first week or two of growth was always observed to break down later on, becoming first flabby and then juicy soft. The nude form cannot be distinguished from Streptococcus; and both Migula and Lehmann and Neumann now write *Streptococcus mesenteroides*. Steamed potato proved excellent for the cultivation of the nude form. The cartilaginous form grew well on carrot. The organism is able to ferment the following carbohydrates with the formation of an acid: grape sugar, cane sugar, milk sugar, maltose, and dextrin. Glycerin is not fermented. It can produce its enormously thick envelope only from grape sugar or cane sugar after it has inverted it. The sheath is composed of a gum-like substance called dextran by Scheibler. It is incorrect to speak of a "dextran fermentation." There is no such thing. The sugars are fermented with production of an acid, but the dextran is as much a product of growth as cellulose. The acid formed from the grape and cane sugar (and presumably from the lactose and maltose) is lactic. This was identified by its calcium salt and zinc salt. Under ordinary conditions no appreciable gas was formed from any of these carbohydrates; but in the presence of calcium chlorid, or in the absence of oxygen, bubbles were given off (apparently CO_2). Calcium chlorid when added in 3–5 per cent. portions to properly prepared nutrient sugar solutions greatly favors the formation of dextran. Growth in such cases was very rapid, 101.5 grams of the Leuconostoc in one instance being developed out of 50 grams of cane sugar in four days. The organism is aerobic and also facultative anaerobic. It can invert cane sugar, but produces no peptonizing or diastatic ferments, and has no effect on cellulose. It is able to take both its N. and C. from peptone or from asparagin, but not from ammonium tartrate. In a 5 per cent. cane sugar solution containing the requisite inorganic salts no growth was obtained on adding ammonium tartrate, ammonium nitrate, or potassium nitrate, which would tend to show that it cannot take N. from these salts. The thermal relations are peculiar. Although a great variety of cultures in all stages of growth were examined for spores, nothing of the sort was found, and it is believed that no spores exist, certainly none of the sort described by van Tieghem. The organism is nevertheless very resistent to heat, even in the nude form. It grows at 9° to 11° C., but forms no acid. At 14° to 15° there is plain growth in 4 to 5 days with production of acid. Grows well at

21° to 23° C. Optimum 30° to 35° C. for the European form, and 30° to 37° C. for the Javan form. The maximum temperature for growth is 40° to 43° C. It cannot grow in juice kept at 43° C., but is not killed. The thermal death point of the frog spawn form is between 87° and 88° C. (five minutes exposure), and of the nude form only a little lower, i. e., between 83½° and 86½° C. It is thought that possibly the thick sheath may have a protective use, as dried and stone-hard specimens brought from Java were found to be alive at the end of 3½ years. A good contrast stain for the frog spawn form is dahlia followed by corallin.—ERWIN F. SMITH.

A New Disease of Tobacco Caused by Phytophthora nicotianæ.—This disease, described by Dr. J. v. Breda de Haan,[1] is most destructive to the seedlings while yet in the seed bed, but attacks older plants as well, extending its ravages under favorable conditions even to the curing barns. In this paper, published early in 1896, the author presents a very satisfactory account of the disease, and precedes the account by a general description of the location of the tobacco fields in the Dutch East Indies. The relations of soil and climate to the parasite are fully pointed out, as are the methods of culture both of the seedlings and of the mature plant.

The disease is, so far as he has been able to determine, confined to the Dutch East Indies. It has probably caused some damage for many years, but was first generally recognized in 1889. In 1893 it was very destructive, owing to the wetness of the season.

The hyphæ of P. nicotianæ enter the leaf by the stomata, and ramify principally in the intercellular spaces. They also pass through the cells, and sometimes fill them with a net-work of hyphæ.

Usually only the haustoria enter the cells. The haustoria are simple unbranched hyphæ, which end freely in the cell.

The mycelium is normally unicellular; but when it is torn, or when the protoplasm is contracted, on account of unfavorable external conditions, the cell contents are separated from the empty part of the mycelium by thin cross walls.

The contents are granular, with scarcely any oil drops, and stain readily with an aniline blue. The hyphæ are about 5 mic. mill. thick, and when free to do so grow long and scarcely branched. Sometimes they may be seen reaching from one seedling to another, looking like delicate threads.

[1] (De. Bibitziekte in de Deli-Tabak veroorzacht door Phytophthora nicotianæ. *Mededeelingen uit's Lands Plantentuin,* Number XV, 1896.)

The spread of the disease is greatly facilitated by the method of growing the seedlings ("bibit"). Several beds are prepared one after another, so that the series contains seedlings of all ages. These are separated by narrow walks, and are themselves narrow enough to permit the coolie to reach all parts of the bed.

In his search for worms or insects the coolie touches diseased and healthy plants, transferring the fungus from one to the other. He also carries the germs about on his clothing or tools and watering pot. The mature plants often show the disease on the tips of the leaves, where persons have brushed against them in passing. The parasite also spreads over the ground, growing from bed to bed across the narrow walks.

In one case only was the agency of wind as good as proven. In this case the center of infection lay to the windward of the later attacked beds, and the beds not in the path of the wind were not attacked.

Conidia are produced in abundance. The conidiophores usually pass out through the stomata, but may push up through the epidermis. At the end a pear-shaped (ob-pyriform as shown in the figures) conidium, 36 x 25 mic. mil. in size is formed, and when ripe is cut off from the conidiophore by a cross wall.

A second conidium is sometimes developed from the side of the first one, and remains connected to it by a short hypha. The contents of the first conidium pass into the second one, in which the swarm spores are developed. The development of the swarm spores requires about 20–30 minutes, at the end of which time the "slime plug" at the apex of the conidium dissolves and they emerge. The number observed in a conidium varied from 10 to 15.

Each swarm spore has one flagellum, and may have another, but of this the author is uncertain. The swarm spores may give rise to secondary conidia. Two cases were observed, but in neither case was the development of swarm spores seen. In the first case the conidium was developed three days after the liberation of the swarm spore in a hanging drop water culture. It remained in the same condition a few days and then perished. In the second case the conidium was found open at the end of four days and the contents gone. No mention is made of swarm spores in the surrounding medium.

Sexual reproduction takes place by means of oogonia and antheridia. The antheridium may arise from the same hypha as that on which the oogonium is borne, or on a different one. The contents of the antheridium are emptied into the oogonium, after which the oospore forms a wall about itself. The process is in all respects the same as that in other

Peronosporaceæ, except that so far as could be ascertained all the contents of the antheridium pass over into the oogonium. This is a departure from the usual course for Phytophthora, in which, according to de Bary (1881) and also Strasburger (Lehrbuch der Botanik, 1894) only a part of the contents pass over.

Phytophthora nicotianæ has the omnivorous habit of P. cactorum C. & L. (P. omnivora de Bary), attacking species of Amaranthus and seedlings of Androng as well as tobacco. The habit of the conidiophores also resembles this species especially in the absence of the swellings under the conidium so characteristic of P. infestans. It differs, however, from P. omnivora in the size of the conidia, which are 50, 60 or 90 mic. mil. long by 35 or 40 mic. mil. wide in P. omnivora, and only 36 x 25 in P. nicotianæ. The size of the conidia brings it closer to P. phaseoli Thaxter in which they are 35–50 x 20–25 mic. mil. in size. The biological identity not having been established the author decides to call the present species P. nicotianæ sp. nov.

The first symptom of the disease is a wrinkling of the edge of the leaf accompanied by wilting, and, if the petiole is attacked, drooping of the leaf. When the attack is severe the seedlings soon change to a dark green slimy mass, covering the surface of the bed. The appearance presented is as though boiling water had been thrown over the bed. On older seedlings and mature plants the disease appears in spots on the leaves. These are at first not well defined, and have a dark center with indefinite circumference ; later, the center dries up and becomes translucent, or if on older leaves, brown, and a dark green border separates it from the healthy portions of the leaves. The disease also attacks the seedlings near the ground, causing damp off. Mature plants sometimes show the disease in this form ; but it is nearly always due to using diseased seedlings for transplanting.

The account of the artificial cultures is unfortunately lacking in definiteness.

The author made cultures in various strengths of cane sugar solution, 5, 10 and 15 per cent., in prune juice, in a decoction of tobacco ashes in water, on sterilized potato slices, on agar-agar mixed with peptone-gelatine and tobacco water, and on slices of banana. All failed, except those in 5 per cent. sugar water and on sterilized potato. These gave fairly good results for a few days, but subsequently also died. The author does not state whether his sugar solution contained any nitrogenous matter, nor whether distilled water was used in making it, but leaves it to be inferred that such was not the case.

Mycelium forming oogonia was brought into a 5 per cent. solution of cane sugar, in which it grew for a few days and produced many fructifications. After six days it remained stationary. The cultures in 15 per cent. sugar solution were poor, and developed what seemed to be a yeast form. Conidia-forming mycelium was also grown in a 5 per cent. sugar solution, and produced for a few days many conidia, the swarm spores of which germinated with long germ tubes.

Agar-agar was mixed with peptone gelatin and leaf decoction (tobacco presumably) in "various ways," but without success. Author does not give the different proportions.

Some mycelium was put on the surface of sterilized potato slices, on which it grew fairly well. The tissue penetrated by the fungus turned red, the starch disappeared, and the cell walls became mucilaginous. The fungus grew intra-cellular, but died after a few days. This culture succeeded best when kept in the dark. The author does not state whether the potato was sterilized by steam or by chemicals.

The relations of the parasite to drying and to darkness were studied. Darkness was found to be generally advantageous to it.

The mycelium and conidia are unable to withstand the least drying. The oospores, however, are more resistant, but succumb to constant drying for 14 days, or when the leaves containing them were subjected to a hot sun bath for five hours on two successive days.

Extensive experiments were conducted in order to combat the disease. It was found that by the free admission of light and air to the seed beds, together with liberal spraying with Bordeaux mixture every five days, or after heavy rains and during damp weather, the fungus could be held in check. Where such measures were taken the tobacco beds were comparatively free from the disease.—A. J. Pieters.

ZOOLOGY.

On the Occurrence of Filaroides mustelarum van Ben. in American Skunks.—Through the kindness of Mr. Gerrit S. Miller, Jr., I have recently had the opportunity of examining a skull of the common skunk (*Mephitis mephitica*) from North Bay, Ontario, the frontal bones of which each exhibited, close to the sagittal plane, a prominent swelling over which the bony tissue was so attenuated as to be easily crushed by the finger. The specimen was still in the flesh, and was preserved in formalin. Mr. Miller tells me that he finds these